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(G*) Inverse Laplace transform of NMR spin-lattice relaxation data

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Traditional NMR data analysis techniques, such as the stretched exponential fit, are used to determine the sample-averaged nuclear spin-lattice relaxation rate $1/T_1$. However, they face difficulty when dealing with heterogeneous materials with NMR signals coming from distinct local environments, especially those with large, overlapping distributions of their Knight shifts and $1/T_1$.

To overcome this, we perform inverse Laplace transform (ILT) to obtain the histogram $P(1/T_1)$ of the $1/T_1$ distribution from the nuclear spin recovery curve $M(t)$. We apply this technique to ^{63}Cu and ^{79}Br NQR data of kagome lattice materials herbertsmithite ($ZnCu_3(OD)_6Cl_2$) and Zn-barlowite ($ZnCu_3(OD)_6FBr$) as well as ^{19}F NMR data of the latter.

From the ^{63}Cu data, we were able to use ILT to observe the gradual emergence of spin singlets with spatially varying excitation gaps below ~30˜K in both materials. We also performed ILT across the ^{19}F NMR spectrum to obtain 3-dimensional ILT-resolved NMR lineshapes, which allowed us to separate the signals coming from two distinct, overlapping sites.

[1] J. Wang *et al.*, *Nat. Phys.* **17,** 1109–1113 (2021)

[2] J. Wang, W Yuan *et al.*, *Phys. Rev. Lett.* (in press)

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